Membrane Technology
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3D-printing has the potential to deliver ceramic membranes with transformational performance gains

Abstract: In the UK, Evove is working with a company that specialises in 3D printing to develop a way of producing ceramic membranes using additive manufacturing. It says the work marks a milestone in the commercialisation of additive manufacturing of membranes and anticipates it will result in a transformational increase in performance for water purification and suspended solids separation, as this brief focus article reveals.

Evove, which has a portfolio of technologies that reduce the cost of filtration and separation of fluids, in a variety of sectors, and the impact that these processes have on the environment, recently signed a joint development agreement with Meta Additive – part of the Desktop Metal Group – to create an advanced additive manufacturing process for 3D printing its ceramic Separonics™ membranes.

Blueprint

Part of Evove's development plan for its Separonics product line of precision engineered 3D-printed membranes (**Figure 1)** is to create a blueprint that will underpin the global roll-out and establishment of regional manufacturing hubs.

Evove says that it is aiming to establish the first full-scale manufacturing process in the northwest of England before the end of 2022.

This will enable ceramic Separonics products to be tested under industrial conditions at a customer's site in the months that follow.

Milestone

Chris Wyres, CEO, Evove says that the signing of this collaboration agreement with UK-based Meta Additive is an important milestone in the commercialisation of the company's Separonics product line.

Wyres commented: ‘The company is recognised as a pioneer in the additive manufacturing sector and we are delighted to be working together to utilise its proprietary binder jet and materials technology.’

‘With a scalable and cost-effective manufacturing capability, we will deliver ceramic membranes with transformational performance gains and enhanced utility at a significantly lower carbon cost.’

Powerful alliance

Simon Scott, CEO, Meta Additive, said: ‘This is a powerful alliance of two successful high-tech UK companies.’

‘We utilise binder jet technology along with novel functional binders to provide advanced additive manufacturing systems that will tackle current and future challenges. We are confident that our products will enable Evove to eliminate the issues associated with traditional ceramic manufacturing techniques, including shrinkage, energy intensive thermal processing and slow production speeds.’

Meta Additive – spun out from the University of Liverpool in 2019 – recently became part of the Desktop Metal Group which has set out to make advanced 3D printing accessible to all engineers, designers and manufacturers worldwide.

The firm's novel chemical approach to 3D printing enables it to manipulate materials at the molecular level, unlocking design potential and smarter, cheaper and more sustainable manufacturing.

Its systems range from smaller scale units, for rapid prototyping, to industrial scale systems for high-speed mass production.

Distinct advantages

Whilst 3D-printing also can be used to make polymer membranes, this joint-development project initially focuses on the production of ones made from ceramic materials.

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The ceramic materials have distinct advantages – especially in a harsh environment involving hot and acidic fluids – but up to now have been fragile in operation and costly to manufacture.

Delivering the perfect membrane

The companies say that they are aiming to deliver perfect membranes. Specific aspects of this work involve a:

new generation of membranes, optimised using artificial intelligence, that delivers transformational performance and enables them to be used in new applications and markets;

precision, digital approach to manufacturing that enables full control of 3D architecture, pore-size/distribution and surface structure;

rationalised process and regional manufacturing, significantly reducing environmental impact;

lower manufacturing cost of ceramic membranes;

technology that opens up a broader market opportunity for ceramics by enabling the production of nanofiltration or reverse osmosis membranes; and

Separonics platform that will also enable the integration of technology, creating smart connected membranes that can monitor and autonomously manage asset performance.

Wyres continued: '3D printing ceramic Separonics with Meta's additive manufacturing technologies, using the latest in material science, means we can effectively eliminate the challenges, high cost and carbon footprint associated with traditional ceramic manufacturing processes.'

'Furthermore, 3D printing enables us to produce novel precision engineered architectures (**Figure 2**) that optimise the fluid dynamics and integrity of the membrane, delivering truly game-changing performance, reducing energy usage for filtration and separation, and extending membrane service life.'

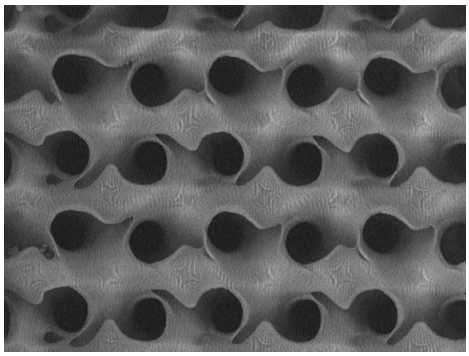
For further information, visit:

www.evove.tech,

www.meta-additive.com &

www.desktopmetal.com

Figure: 3D-printed SeparonicsTM from Evove will achieve a level of architectural precision that only additive manufacturing can reach.



(photograph courtesy of Evove)

Figure: A specific example of a precision-engineered architecture – a ceramic hollow-fibre SeparonicsTM membrane.

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(photograph courtesy of Evove)

Advisor appointed to support additive manufacturing capabilities

Tim Freeman recently joined Evove's advisory board – complementing David Pears, Will Sarni and Tom Williams with expertise in powders as a raw material, intermediates or finished products.

He supports the company's additive manufacturing capabilities as its creates a manufacturing blueprint for Separonics™ during 2022. The board is chaired by Jeremy Pelczer, a non-executive director of Evove.

Rebranding to reflect growth strategy and development of latest membrane technology

In December, G_2O Water Technologies changed its brand and name to Evove to reflect both a new growth strategy and the product line of membranes that it is developing (*Membrane Technology*, January 2022, https://doi.org/10.12968/S0958-2118(22)70002-X).

The UK-based firm says it has already successfully applied graphene oxide coatings and a variety of 3D-printed spacer and insert technologies that enhance the performance of conventional membranes.

Redesign and optimise

It is now also developing a product line called Separonics™. Described in the main text, this uses additive manufacturing techniques to completely redesign and optimise the 3D architecture of ceramic and polymer membranes – delivering transformational performance gains for water treatment across a broad range of sectors and uses.

These include the food and beverage, life sciences, domestic and municipal industries, and applications such as recycling industrial wastewater, resource harvesting and desalination.

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Substantially reducing CO2 emissions in food and beverage manufacturing and biotechnology processes

Abstract: This focus article briefly describes membrane-based technology developed by Toray Industries Inc that is targeted at applications in the food and beverage sector and for use in biotechnology processes. The Japanese company says that it is capable of substantially reducing carbon dioxide (CO2) emissions in these industry sectors and applications.

Toray Industries Inc has developed what it describes as an exceptionally robust hollow-fibre ultrafiltration (UF) membrane module for food and beverage manufacturing and use in purification and concentration processes in the biotechnology industry. It has already started supplying samples to customers.

Carbon neutrality

This module has been designed to save energy and contribute to carbon neutrality by attaining CO_2 emissions that are more than 80% lower (**Figure 1**) than conventional thermal concentration processes used in the food production sector.

Hollow-fibre membranes have become one of the mainstream technologies used in liquid filtration because of their excellent separation, high membrane integration, reduced footprint and superb area utilisation efficiency, says Toray.

The company's exiting hollow-fibre membranes are used widely in water treatment. This is because its polyvinylidene fluoride UF hollow-fibre membrane is durable and possesses excellent separation capabilities.

Crossflow filtration

The latest UF module described here, which employs an outside–in type crossflow filtration design, takes advantage of the company's high-strength hollow-fibre membrane technology for water treatment.

Crossflow filtration is a common technique, through which feed passes parallel to membrane surface and prevents turbidity from accumulating. Pressure losses from this design are about one-third of those of the inside–out configuration that food companies normally use.

This means that it is possible to filter and concentrate highly turbid or viscous liquids, which is challenging when regular membranes are used.

Large membrane area

Other benefits of the module are that it features a large membrane area (**Figure 2**) which reduces the number of modules needed – halving space requirements and potentially lowering cleaning and equipment costs by more than 20%.

The module performs well in environments where steam 125°C (257°F) and hot water 90°C (194°F) are present, which enables it to be used in high-temperature filtration and undergo thermal sterilisation.

According to Toray, filtration testing of the module, when it was applied to a high-turbidity microbial culture solution, demonstrated stable, long-term filtration, with steam sterilisation preventing bacterial contamination for more than 20 days.

Mass production

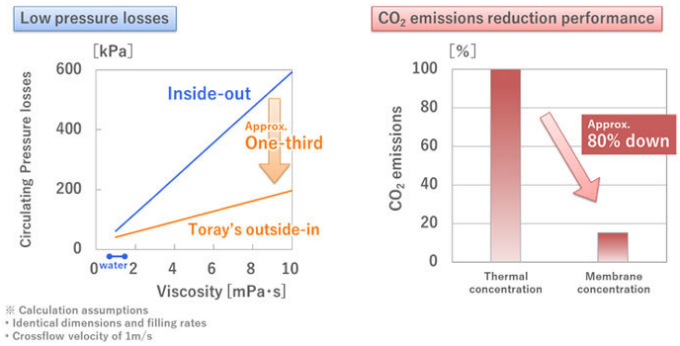
Toray says that it will accelerate development, with a view to full-fledged mass production, and is also planning to build collaborative ties with engineering companies in Japan and outside the country to develop an array of uses.

These include using it in applications involving high-viscosity and high-turbidity raw-water which, to date, have employed solid–liquid separation technologies based on diatomaceous earth filtration or centrifugation. They also encompass food manufacturing and bioproduction processes in which production lines require thermal sterilisation.

For further information, visit:

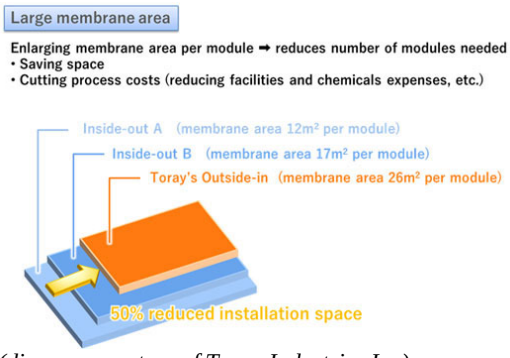
www.toray.com

Figure: Low pressure loss characteristics and CO2 emissions reduction performance.



(diagram courtesy of Toray Industries Inc)

Figure: Benefits of a large membrane area.



(diagram courtesy of Toray Industries Inc)

Recent Toray membrane developments reviewed

In addition to the robust hollow-fibre ultrafiltration (UF) membrane module described in the main text, Toray Industries has been actively working on a range of other areas of membrane-related technology, as reported previously.

Energy-saving UF

The company has developed an energy-saving UF membrane, based on polyvinylidene fluoride (PVDF), for water treatment that possesses an exceptional virus removal rate and high water permeability (*Membrane Technology*, October 2021, page 7, https://doi.org/10.1016/S0958-2118(21)00156-7).

According to the manufacturer of membranes for applications that also include microfiltration, nanofiltration, reverse osmosis and membrane bioreactors, it is capable of producing water safely and economically – whilst using minimal energy – for a range of applications.

Boosting water production

It has also developed energy-efficient sea-water RO membrane technology that aims to boost water production (*Membrane Technology*, May 2020, pages 5–6, https://doi.org/10.1016/S0958-2118(20)30087-2).

It says that the RO membrane for desalinating sea water is capable of producing 70% more clean drinking water in an energy-efficient way than is currently possible using conventional technologies.

Improving water recovery

Another article, published in August 2019 (*Membrane Technology*, pages 8–9, https://doi.org/10.1016/S0958-2118(19)30151-X), looks at membrane technology that the firm has developed to dramatically improve water recovery.

It has been applied to a small-sized RO membrane element – doubling its water recovery capabilities, compared with existing RO membrane elements of various sizes.

Low fouling
Toray has also recently developed a low-fouling RO membrane, designated the TLF Series.

According to the company, it features low-fouling characteristics to various types of foulants, whilst maintaining high performance at a low operating pressure to realise additional cost-savings (*Membrane Technology*, October 2018, page 5 https://doi.org/10.1016/S0958-2118(18)30202-7).

The TLF-400DG has excellent resistance to membrane fouling, leading to reduced cleaning frequency and a longer membrane service life.

The TLF's enhanced durability against chemicals prevents damage during membrane cleaning and, additionally, the lower required feed pressure reduces power consumption throughout its service life, says the company.

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Membrane for industrial exhaust gas treatment possesses high separation factor

Abstract: Ceramics company NGK Insulators Ltd has developed a carbon dioxide (CO2) separation membrane for treating industrial exhaust gas. Tests have confirmed that it possesses a significantly higher separation factor than that of a conventional deca-dodecasil rhombohedral (DDR) zeolite membrane. Here, we briefly look at the technology that is set to be commercialised in 2030.

Amid the global shift towards carbon neutrality, there is a growing social need for CO_2 separation and recovery technology for industrial exhaust gas that is emitted from plants and related facilities.

NGK recently reported that it is using its membrane manufacturing technologies and techniques for forming uniform membranes to develop a new ceramic CO_2 separation membrane that can be used for industrial exhaust gas treatment.

The company says that it has been successful in developing a DDR-type zeolite membrane, which is one of the world's largest CO_2 separation membranes.

Demonstration testing of this membrane technology is currently in progress with a view to using it for separating CO_2 from associated gas and natural gas.

Molecule size

A conventionally developed DDR-type zeolite membrane can be used for CO_2 separation, based on the difference in size of the molecules involved.

It is capable of separating CO_2 in associated gas and natural gas, since methane, their major component, has a larger molecule size than CO_2. On the other hand, in industrial exhaust gas, the major components are nitrogen and oxygen, which have molecule sizes similar to CO_2.

This means that it is difficult to precisely separate CO_2 from industrial exhaust gas using a DDR-type zeolite membrane.

Adsorption characteristics

The recently developed CO_2 separation membrane, for industrial exhaust gas treatment, makes use of a difference in adsorption characteristics (affinity) for CO_2 molecules, in order to separate CO_2 from nitrogen and oxygen, which increases the CO_2 separation factor (**Figure 1**).

Testing

In testing, carried out with simulated industrial exhaust gas, the membrane achieved a CO_2 separation factor which is approximately five times that of a conventionally developed DDR-type zeolite membrane used for CO_2 separation, says NGK.

Using the characteristics of ceramics that can be employed under harsh conditions, the company is working to increase the separation factor even further for high-temperature industrial exhaust gases – aiming for commercialisation in 2030 after demonstration testing.

Realisation of carbon neutrality

In April 2021, the NGK Group formulated the NGK Group Environmental Vision.

This calls for a 50% reduction in CO_2 emissions, compared with fiscal 2013, by fiscal 2030 and aims to achieve net zero emissions by fiscal 2050.

Through the development and provision of various membrane technologies, NGK says that it will work to reduce CO_2 emissions in the future by spreading technologies for the separation, recovery and effective use of CO_2 – contributing to the realisation of carbon neutrality.

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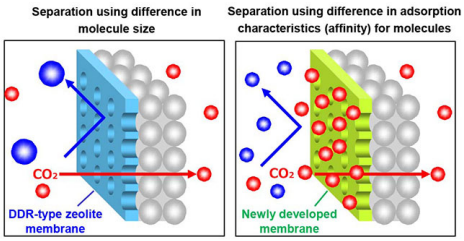
For further information, visit:

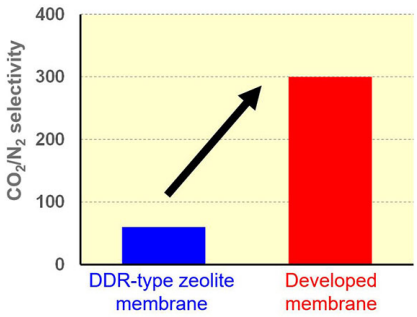
www.ngk-insulators.com

Figure: A sub-nano-ceramic membrane separation system.



(diagram courtesy of NGK Insulators Ltd)

Figure: Comparison of the separation factor of CO2 and nitrogen (N2).



(diagram courtesy of NGK Insulators Ltd)

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Water desalination equipment market expected to reach U$22.79 billion by 2028

Abstract: The size of the market worldwide for water desalination equipment is forecast to reach U$22.79 billion by 2028, according to a report produced by Grand View Research Inc.

The US market research and consulting company says that it is expected to expand at a compound annual growth rate (CAGR) of 7.1% from 2020 to 2028.

Increasing water scarcity, the depletion in reserves of fresh water, and fast-paced advancements in desalination technology are anticipated to have a positive effect on growth.

The study, entitled 'Water Desalination Equipment Market Size, Share & Trends Analysis Report by Technology (Reverse Osmosis (RO), Multi-stage Flash (MSF) Distillation), by Source, by Application, by Region and Segment Forecasts, 2020–2028', says that the RO technology segment accounted for over 55.0% share of the global revenue in 2020. This is because of its inexpensive installation costs, ease of processing, capacity to treat various types of feed-water and minimal usage of chemicals.

The municipal application sector accounted for more than 50.0% share of the global revenue in 2020, driven by the growing urban population, coupled with expanding megacities that are putting a strain on the available water sources, thereby augmenting the market growth.

Because of the increasing scarcity of water for domestic and industrial use – which is expected to be a key driver in augmenting the demand for sea-water desalination – the sea-water source segment is projected to expand at the fastest CAGR from 2020 to 2028.

In terms of geography, Grand View Research found that the Middle East and Africa accounted for over 40.0% share of the global revenue in 2020. This is attributed to the scarcity of water resources in this region, which is likely to create a strong demand for water desalination equipment over the forecast period.

Deteriorating environmental factors, such as fluctuating weather patterns, rising pollution and deforestation, have resulted in water scarcity and drought-like scenarios worldwide.

The governments of various countries are investing in the development of desalination facilities to combat this situation, which is expected to drive the market, says Grand View Research.

In addition, the rising adoption of renewable energy to desalinate water is gaining traction in the market as conventional systems require a considerable amount of energy to function, making them expensive and impracticable for usage in underdeveloped countries. The study indicates that such developments are also expected to drive the demand for water desalination equipment over the forecast period.

For further information, visit:

www.grandviewresearch.com

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Osmoflo contracted to deliver major RO plant for saline water treatment in Australia

Abstract: In partnership with Aerison Pty Ltd, Water treatment company Osmoflo has been awarded a contract for a major water treatment system at the Roy Hill Mine – a mining, rail and port operation located approximately 340 km (211 miles) south-east of Port Hedland in the Pilbara region of Western Australia.

Osmoflo says that the ultrafiltration and sea-water reverse osmosis (UF-SWRO) plant, which will have a capacity of 40 million litres (10.6 million gallons) per day, will be one of the largest facilities it has delivered globally over its thirty-year history, and will also constitute one of the largest non-municipal SWRO facilities built in Australia to date.

The plant is scheduled to be commissioned in the first quarter of 2023.

Prime contractor Aerison provides engineering and design, construction and maintenance services to the mineral-processing, energy and infrastructure sectors. Its engineering capabilities reduce the impact of industry on the environment, and through its partnership with Osmoflo, the project will deliver superior water treatment infrastructure to support operations at the mine site.

Osmoflo technology has been used at Roy Hill mine for several years (*Membrane Technology*, September 2019, pages 2–3, https://doi.org/10.1016/S0958-2118(19)30159-4).

In mid-2019, it successfully completed delivery of the current brackish-water reverse osmosis/water treatment plant 1 (BWRO/WTP 1), rated at 20 million litres (about 5.3 million gallons) a day. It also provides services under a operation and maintenance contract.

Osmoflo has developed a robust and innovative system, drawing upon extensive operational and process experience at the site. It says that its team maximised the use of the existing WTP 1 assets, reducing the capital intensity of the facility expansion.

As lead engineering, procurement and construction contractor, Aerison brought its in-house capabilities – spanning civil, mechanical and electrical disciplines, and a long history in delivering complex projects of scale to asset owners in the Pilbara region of Western Australia – to create an ideal partnership with Osmoflo.

Takayuki Inoue, CEO, Osmoflo, observed: ‘We are pleased to be working again with Roy Hill to provide it with a robust and reliable water treatment system to meet its water needs for the foreseeable future.’

‘The complementary knowledge, experience and capabilities of both Aerison and Osmoflo enabled our team to respond to Roy Hill Mine's competitive early contractor involvement process, with a superior technical solution – competitively priced and delivered under a very challenging schedule and to meet Roy Hill's strict technical requirements and specifications.’

Paul Laybourne, Director of Projects, Roy Hill, added: ‘The Osmoflo–Aerison team presented a robust, efficient, value-for-money water treatment system that will provide our mine operations team with maximum flexibility and water availability at all times. It also provided a high level of integration and ongoing utilisation of our existing BWRO/ WTP 1 plant.’

For further information, visit:

www.osmoflo.com &

www.aerison.com

(Also see news focus entitled ‘Mining sites in Australia benefit from using Osmoflo water treatment technology’, *Membrane Technology*, June 2018, pages 6–7, https://doi.org/10.1016/S0958-2118(18)30118-6).

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Membranes extract valuable fibres – turning waste into sellable ingredients

Abstract: Membrane systems from Alfa Laval are set to be used at a food facility in Denmark to produce healthy dietary fibre from crop leftovers.

Alfa Laval, which specialises in heat-transfer, centrifugal separation and fluid-handling technology, says that the membranes will extract fibres from sources such as brewers' grains, corn stover and wheat straw – improving the circularity of the food chain.

They will be used to recover and purify crop leftovers, mainly supplied from local farmers, and process this material into prebiotic dietary fibre.

These fibres are not digestible by the human body, but help ensure healthy bacteria growth in the stomach which can help with various digestive problems and boost the immune system.

'This is an interesting order in a new and promising application for our membrane systems, improving the circularity of the food chain,' commented Nish Patel, President, Food & Water Division, Alfa Laval.

'Our efficient membranes will be able to extract valuable fibres and, thereby, turn former waste into sellable ingredients, which will benefit both our customer and the environment.'

Towards the beginning of 2021 Alfa Laval acquired US beverage technology company Sandymount, which has developed and patented membrane-based reverse osmosis (RO) technology to concentrate beer (*Membrane Technology*, February 2021, page 1, https://doi.org/10.1016/S0958-2118(21)00017-3).

For more information, visit:

www.alfalaval.com

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TFF systems bring large-scale performance to single-use filtration and purification

Abstract: US-based ABEC Inc has developed large-scale single-use tangential flow filtration (TFF) technology.

The provider of integrated systems and services for biopharmaceutical manufacturing claims that its Custom Single Run (CSR®) TFF systems possess the industry's largest flow rates and filter areas. In addition, they enable the highest TFF productivity to be achieved in a single-use format.

The CSR TFF is capable of operating at flow rates greater than 240 litres (about 66 gallons) per minute across cassette-type filter areas up to 40 m^2 (430 ft^2) – both approximately triple the levels currently available for single-use TFF, and similar to the performance achievable using stainless-steel systems.

It is designed for the latest next-generation flexible manufacturing facilities, and customers no longer need to compromise on TFF productivity and cost, using multiple smaller single-use TFF systems or a large stainless-steel unit, says the company.

The CSR TFF also features a unique single-use cone-bottom retentate mixing vessel with a high turndown ratio. This vessel is tightly integrated with the recirculation loop, resulting in low hold-up volumes and maximum product concentration and recovery.

To achieve a high pressure and flow, the firm says that it implemented unique single-use design elements, including rigid-walled polyvinylidene fluoride tubing and a cassette manifold made from high-density polyethylene.

The systems can be customised for specific applications and are able to accommodate different filter membrane types. This means that they are ideal for commercial-scale ultrafiltration or diafiltration for monoclonal antibody manufacturing, but also could be used for the filtration and purification of other biopharmaceuticals.

For more information, visit:

www.abec.com

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H2O Innovation's Piedmont secures international orders for housings and couplings

Abstract: H2O Innovation Inc's independent subsidiary Piedmont recently secured 13 orders for fibreglass reinforced (FRP) cartridge filter housings, stainless steel duplex couplings and PiPerLinkTM permeate connectors.

Canada's H_2O Innovation, which designs and provides custom-built and integrated water treatment systems based on membrane filtration technology, for municipal, industrial, energy and natural resources end-users, says the orders are worth C$9.3 million.

According to Piedmont, these projects span the globe – from Latin America to North Africa, the Middle East and Asia. It also concluded its first sales of the PiPerLink permeate connector, launched in November 2021.

Piedmont, which focuses on corrosion-resistant equipment for desalination plants in the industrial and municipal markets, has experienced record sales for its sea-water desalination products, says H_2O Innovation.

Many of the orders placed included a variety of products from the firm's FRP cartridge filter housings, cartridge elements and flexible couplings product ranges. In a few cases, products from H_2O Innovation's Specialty Chemicals Group are being sold to the same customer or for use in the same desalination project.

Commenting on the orders, Gregory Madden, Chief Strategy Officer, H_2O Innovation, said: 'We are excited to see the large number of projects and volume of business won by the dedication and hard work of the Piedmont team, especially considering the cross-business synergies with our Specialty Chemicals Group.'

'Desalination is an important segment for the water industry, and we are optimistic about its growth.'

As reported previously, Piedmont recently secured three large orders totalling C$3.3 million for FRP cartridge filter housings and duplex stainless couplings (*Membrane Technology*, February 2021, page 3, https://doi.org/10.1016/S0958-2118(21)00023-9).

In addition, in *Membrane Technology* February 2020 (page 3) we reported that it had secured several orders totalling C$3.5 million for similar products (*Membrane Technology*, February 2020, page 3, https://doi.org/10.1016/S0958-2118(20)30023-9).

For further information, visit:

www.h2oinnovation.com &

www.piedmontpacific.com

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Asahi Kasei constructs assembly plant to expand filter production capacity

Abstract: Asahi Kasei Medical is building a new assembly plant in Nobeoka, Miyazaki, Japan to expand the production capacity of its PlanovaTM filters.

Construction work is scheduled to begin in the third quarter of 2022 and is expected to be completed in early 2024. In order to enhance quality and production efficiency, the facility will operate as a smart factory through manufacturing automation and digital transformation.

The COVID-19 pandemic has triggered the rapid growth of the biotherapeutics market and increased the urgent demand for Planova filters, says Asahi Kasei Medical. These are needed by pharmaceutical companies to develop and commercially produce new drugs.

The company is reaching significant milestones in expanding production capacity to meet such demands. This latest plant follows the investment announced in 2021 for the expansion of the spinning plant for Planova BioEX in Oita (*Membrane Technology*, October 2021, page 2, https://doi.org/10.1016/S0958-2118(21)00148-8).

Six existing plants – including the spinning plant completed in 2019 in Miyazaki, Japan (*Membrane Technology*, November 2019, page 5) – that produce cellulose hollow-fibre membranes for the company's Planova N series filters have been operating efficiently and without any disruption to meet increasing demand worldwide, says the company.

For further information, visit:

www.asahi-kasei.co.jp/medical/en

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End-users are encouraged to investigate a wide range of filtration options

Abstract: As the increasing use of crossflow membrane filtration becomes ever more beneficial to manufacturing companies, UK-based Axium Process Ltd is actively encouraging end-users to investigate further the wide range of filtration options available for their applications.

The producer of hygienic process systems, which specialises in cross-flow filtration and separation technology, says that tailored research involving pilot trials can result in a more efficient approach to optimising separation performance and productivity.

Derek Davies, Business Development Director, Axium Process, said: 'Crossflow membrane technology is used in almost every industry and has many advantages. However, identifying the ideal membrane and operating conditions is key to success.'

'There are four levels of filtration, with many variables to consider, including factors such as media type, temperature, pressure and the pH range of the environment.'

Davies continued: 'Research can help end-users make the right decision and will result in a customised system that is tailored to their needs. The research involves pilot-plant trials that more closely replicate real-life conditions, and detailed performance analysis that helps identify optimal parameters, with the most effective membrane.'

Axium Process operates independently of membrane manufacturers and can carry out pilot trials at its test facility in Swansea or at end-users' premises. The company says that the trials help eliminate uncertainty and operational issues by accurately predicting separation performance, process viability, system design parameters and operational costs.

It says that its experienced team have the skills to design and manufacture crossflow membrane filtration systems for a wide variety of applications that meet international regulations and recognised hygienic standards.

In 2008 the company reported that its in-house capabilities included design, testing, fabricating and commissioning of customised and unique process membrane filtration systems (*Membrane Technology*, February 2008, page 7, https://doi.org/10.1016/S0958-2118(08)70038-7).

For further information, visit:

www.axiumprocess.com

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Inaugurated RO facility ranked as the world's largest by Guinness World Records

Abstract: The International Desalination Association (IDA) reports that on 30 March 2022, Rabigh 3 independent water plant (IWP) – the world's largest reverse osmosis (RO) desalination facility – was inaugurated in Saudi Arabia.

The facility, with a capacity of 600 000 m^3 (158.5 million gallons) per day, has been recognised as the "world's largest RO desalination facility" by the Guinness World Records, the ultimate global authority on record-breaking achievements.

The plant is characterised by a high level of operational efficiency. According to the IDA, it is also the most environment-friendly desalination plant in the world because during day-to-day operations it has the lowest electricity consumption compared with other facilities.

The opening ceremony for the Rabigh 3 IWP took place in Rabigh, Saudi Arabia with participation from H.E. Eng. Abdulrahman Abdulmohsen A. AlFadley, Minister of the Environment, Water and Agriculture; H.E. Eng. Khaled Al Qureshi, CEO of the Saudi Water Partnership Co; Mohammad Abunayyan, ACWA Power Chairman; and Faisal Al Nowaiser, member of the board of directors of SBCG–SAWACO.

SAWACO Water Desalination is a member of the Saudi Brothers Commercial Group (SBCG) and is described as a central component of water-related activities of this Saudi-based Group.

'Rabigh 3 Desalination Plant meets the clean water needs of about one million housing units in both Makkah Al-Mukarramah and Jeddah, and ensures a sustainable and reliable supply of water to the citizens and residents of the two cities and neighbouring villages,' stated H.E. Eng. Abdulrahman Abdulmohsen A. AlFadley – especially during peak demand periods in the holy month of Ramadan and the Hajj season.'

'The investment cost of the station is SAR2.6 billion (US$750 million).'

H.E. Eng. Khaled al Qureshi, added: 'It is the biggest sea-water RO plant in the region and the first time we applied an energy cap of 3.5 kWh, which reduces the energy consumption and, in turn, reduces the entire desalination sectors average tariff by 30–40%, resulting in reduced overall carbon emissions.'

'We have also mandated a local content contribution of 40% for construction and 70% local content for operations. We believe Rabigh 3 IWP is the milestone of change in the desalination sector, and all have followed this outstanding example of innovation.'

For further information, visit:

www.sawaco.com &

https://idadesal.org

(Also see 'Rabigh 3 produces its first permeate stream', *Membrane Technology*, October 2021, page 4, https://doi.org/10.1016/S0958-2118(21)00152-X.)

Membrane Technology
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Defence contractor adds desalination systems to is marine services

Abstract: In the USA, Fairbanks Morse Defense (FMD), which builds, maintains and services naval power and propulsion systems, has acquired Maxim Watermakers, a privately-owned firm, based in Shreveport, Louisiana, that provides desalination and water treatment technologies for marine defence applications.

The company's treatment systems, which provide life-sustaining water for crews during ship deployments, position Maxim as an essential addition to FMD, enabling it to provide turnkey, onboard systems, and global technical support that ensure crews are always mission-ready.

Maxim's products and services include evaporators, reverse osmosis (RO) systems, salinity monitoring equipment, cleaning solutions, engineering, parts fabrication and technical services.

It currently delivers two lines of sea-water RO desalination systems and one brackish water RO desalination system. Its heat recovery evaporators use waste heat to make high-quality potable water from sea water, brackish water, or sources of contaminated feed-water.

‘What we do is critically important to the safety of our nation and the world, and FMD is firmly committed to being a single-source partner that can deliver turnkey services when and where our customers need us with no time to spare,’ said George Whittier, CEO, FMD.

‘Maxim has a strong reputation of producing high-quality water treatment systems with a customer-centric approach, which makes it a great addition to our rapidly growing array of best-in-class marine technologies.’

Brian Herbert, CEO, Maxim, added: ‘Like FMD, Maxim does not take lightly the role that it plays in making sure its military marine customers are mission-ready.’

‘Our commitment to quality has already earned us the trust of military leadership and becoming part of FMD further strengthens that trust. As part of the FMD brand, we will be able to deploy our technology and expand to more ship classes more quickly.’

For further information, visit:

www.FairbanksMorseDefense.com &

https://www.maximwater.com

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IDE Water Technologies nominated for GWI award

Abstract: IDE Water Technologies, which specialises in the development, engineering, construction and operation of thermal and membrane-based desalination facilities and industrial water treatment plants, has been shortlisted for the 'Desalination Company of the Year 2022' award by Global Water Intelligence (GWI), which provides business information for the international water sector.

According to GWI's Web-site, "IDE's uniquely driven, breakthrough technology and flawless progress on a series of key projects in 2021 notably stood out among other applicants, displaying a willingness to push the boundaries of water technology and expand the role of desalination in the world".

IDE says that it added an astonishing 1 million m^3/day of capacity, including new plants in Israel (Sorek B facility) and Formosa Plastics, in Taiwan – tackling desalination challenges wherever and however they arise.

In addition, the completion of a pilot plant in Abilene, Texas, USA, demonstrated new Pulse Flow RO technology that successfully achieved 80% more product water from brine reject, illustrating its recovery capabilities and efficiency for the industry.

The winners of the 2022 Global Water Awards will be announced at the Global Water Summit, which is being held on 17 May 2022, at the La Quinta De Jarama in Madrid, Spain.

For further information, visit:

www.ide-tech.com &

https://globalwaterawards.com/2022-desalination-company-of-the-year

(Also see 'Israel's largest desalination plant Sorek B employs DuPont's FilmTec membranes', *Membrane Technology*, October 2021, pages 1 & 14, www.magonlinelibrary.com/doi/full/10.1016/S0958-2118(21)00146-4).